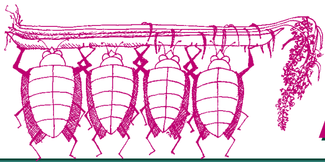
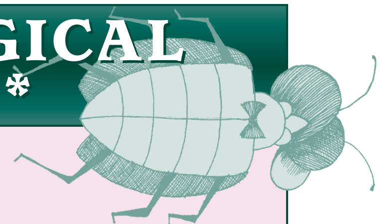


ACTIVITY 6 GRADES 6-12

CHOOSING BIOLOGICAL CONTROL AGENTS*



Objectives

➡ Students will develop criteria to use when choosing biological control agents.

➡ Students will evaluate potential agents for use as biological control against purple loosestrife.

Time Requirement

45 minutes.

Wisconsin Model Environmental Education and Science Standards

Environmental Education: **A.8.1, A.8.4, A.8.5, A.8.6, B.8.8, B.8.14, D.8.1, D.8.6, A.12.3, A.12.4, A.12.1, C.12.3, C.12.4, D.12.1. *Science*: C.8.2, C.8.6, C.8.7, C.8.9, C.8.11, F.8.7, G.8.5, H.8.2, B.12.4, C.12.6, F.12.7, F.12.8, G.12.5, H.12.4, H.12.6.**

DESCRIPTION

Scientists who conduct biological control programs for a pest must first choose appropriate control agents, typically, the pest's natural enemies. Biologists must then decide whether or not these agents are safe for importation and likely to be effective. This activity simulates this process with actual examples from the purple loosestrife biological control program.

PROBLEM

How do scientists develop and apply the criteria with which to choose natural enemies for use in biological control programs?

MATERIALS

- ❑ Copies of student handout "Rules for Selecting and Releasing Biological Control Organisms," (page 21).
- ❑ Copies of student handout "Candidates for Biological Control and their Characteristics," (pages 22-23).

PROCEDURES

1. Divide the class into teams of three. Each team should brainstorm a list of rules to be used when choosing biological controls.
2. Distribute copies of the student handout, "Rules for Selecting and Releasing Biological Control Organisms."
3. Using the handout, edit or modify the lists of rules for picking a biological control.
4. Use the handout "Candidates for Biological Control and Their Characteristics" to categorize each insect as acceptable or unacceptable biological controls for purple loosestrife. Have students rank the top five control agents and justify their choices.

Collect class data and come to a consensus on rules and the top five biological control choices for purple loosestrife.

BACKGROUND INFORMATION

Biological control is the process of using one organism to control another that has become a pest. A pest is often an organism from another region that has become a problem because it was imported (often accidentally) without its natural enemies. An introduced pest's natural enemies can be imported from their native region to help establish a balance between the pest and its enemies in the newly occupied territory. This must be done with care, however, and requires much research and analysis to be sure the imported enemies will not themselves become pests in the new region, perhaps even worse than the pest they are introduced to control.

Natural enemies, such as predators, parasites, and diseases, can all be used to help control pest species. A pest's natural enemies will be found in its native home. If the pest is an exotic, that is, has been introduced from another remote region, its natural enemies must be found there. Such enemies are usually the best for biological control because they are already well adapted for feeding on the pest and, if carefully chosen, are unlikely to feed on other species in the new region. If such a control species can be found, large numbers of these enemies can be released. Doing this could both be environmentally safe to use and make the pest less competitive in its new habitat.

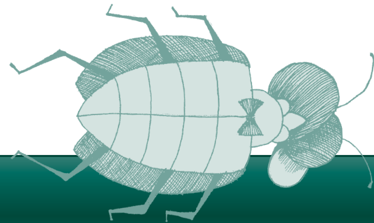
In natural biological communities, such as wetlands, well-chosen natural enemies should help native species compete more effectively with exotic pests, such as purple loosestrife, and even begin to replace them. This should help preserve the diversity and quality of such areas. (Biological control can also be used in agricultural settings.)

Few organisms native to the new country are selected as biological control agents for an exotic pest because they are not usually well adapted to feeding on the pest species and are, of course, capable of feeding on other native organisms. Native control organisms would probably have to be produced in larger numbers than the pest's natural enemies to achieve the same level of control. Native control organisms are also more likely to become pests themselves since they can shift from the exotic host to native hosts that may not be prepared for the introduced organism's unusually large numbers.

There are general rules that scientists follow in trying to find good potential biological control organisms. Any chosen control species' actual value in controlling a pest will not be known until

PHOTOS: CORNELL UNIVERSITY

Some predators from a pest species' native region can be used as effective biological controls in the pest's new environment.



Activity 6. CHOOSING BIOLOGICAL CONTROL AGENTS

(continued)

it is released on or near the pest. The rules, however, make it possible to both avoid control species that will be unsafe to use and easier to find control species that will be effective and less expensive. One such list of rules is provided on the accompanying student handout. Note that the first and most important rules are ones that deal with safety. Other considerations come later. These rules must be applied with care and intelligence, erring on the side of safety.

Purple loosestrife is native to Europe and Asia. Therefore, its control organisms are most likely to come from there. In the 1980s, the search for potential control organisms was begun throughout Europe and over 100 different species of insects were found that feed on purple loosestrife. This number was initially reduced to six, then to five, by applying the rules discussed above. Finally, only four of these have since been introduced to North America, starting in 1992, because an additional problem was detected in one species while in pre-release quarantine here. Care must constantly be exercised. Additional monitoring of all the released species continues to insure they are safe for use. Currently, released insects include both *Galerucella* beetles, *Hylobius*, and *Nanophyes marmoratus*.

We have assembled a short list of some of the insects initially studied for purple loosestrife control work, along with their characteristics that may be important in choosing safe and effective control organisms. This list is provided in the second student handout.

Since there are many generalist plant predators here in North America, some or even many will likely feed on purple loosestrife in different places and times. Some of these may even become locally abundant on the plant as they exploit an acceptable, newly found food source. This additional help in controlling loosestrife is expected. It is unlikely, however, that any native predators will be artificially reared because it is doubtful that they can sufficiently slow the increase of purple loosestrife in our wetlands and difficult to predict what problems they may cause by shifting to native hosts. Biologists, however, are always searching for new, safe, effective and inexpensive control methods. If you ever think you have found an organism that might be worthy of further study, please do not hesitate to inform us of your discovery by e-mailing **brock.woods@dnr.state.wi.us** or calling (608) 221-6349.

STUDENT ASSESSMENT

Use the following factors when assessing student performance:

- Contribution to class discussion and justification of choices.
- Ability to work with peers.
- Explanation of the importance of biological control.
- Any assigned research on past successes and failures in biological control.

[*] Revised with permission from "Choose Your Enemies Carefully!" in *Biodiversity, Wetlands, and Biological Control*.

Rules for Selecting and Releasing Biological Control Organisms

Scientists always apply rules, such as those listed below, when choosing organisms to be used for biological control.

A. Safety considerations

An organism that is to be introduced as a biological control agent for a pest <u>must</u>:

1. **Be very host specific, that is, prey only, or mostly, on the target pest.** If it can survive on, or even feed extensively on, other organisms it may become a pest itself. It would also be useful if it had a wide variety of predators so that its own numbers will never exceed what is necessary to control the pest.
2. **Have few, or no, other direct or indirect effects on other organisms.** For example, it must not compete in any serious way with other organisms for resources. This could allow it to harm them indirectly or even attack them. An example is the multi-colored Asian lady beetle here in Wisconsin that, in addition to eating more than the initial target pest (aphids,) also collects in <u>large</u> numbers in people's houses in fall—space competition with us!
3. **Not harbor internal parasites or pathogens that would be unwise to import.**

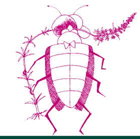
B. Effectiveness and cost considerations

An organism that is to be introduced as a biological control agent for a pest <u>should</u>:

4. **Come from a climate and biological community similar to those into which it will be introduced.** It must be able to tolerate temperature, seasons, level of moisture, etc. in the new country. For example, a control agent for a pest of citrus trees must be able to withstand the high heat of most citrus-growing areas in the United States. An insect that required an extended cold period (winter) to complete its development would not be a suitable candidate.
5. **Be common and easy to capture.** Large numbers of them will likely be necessary and if they are common and easy to get, collecting many should neither harm populations in the home country, nor be difficult and expensive.
6. **Be easy to raise and release in large numbers and/or have a high reproductive potential in its new home.** Again, most programs will need millions of individuals. Usually, large numbers must be propagated and released cheaply, or a released few must increase rapidly on their own after release, or both. If neither works, either it will not control the pest or costs will be too high. Large-scale releases are usually the best way to ensure that enough males and females (in the case of larger organisms) find each other to mate and reproduce in their new home. However, high reproductive potential may be as effective and cost less, especially with good natural dispersal. For example, a few cheaply produced individuals of a disease-causing organism that reproduces rapidly may spread quickly causing a wide-scale outbreak of the disease in the pest.
7. **Have broad tolerances to withstand rigors of shipping, etc**. It must survive to be useful. Costs will be high if special care has to be taken during shipping, propagation, etc.
8. **Be able to escape predation until numbers exceed what is needed to control the pest.** This is a complex ecological consideration. See Point 1 above.
9. **Be able to disperse once released.** Pests may be spread out, hard to find or get to and it may otherwise be hard or very expensive to get control agents to them.
10. **Be suitable for combining with other potential control organisms to maximize control effect.** Multiple attack points on the target pest, minimal competition among control agents, etc. should all be considered.
11. **Be able to remain in the new country at a low level, without problems, ready to attack the pest whenever necessary.** Pest outbreaks will likely occur periodically …

Candidates for Biological Control and their Characteristics

SCIENTIFIC NAME	TYPE OF INSECT	LOCATION	PLANT PART	ABUNDANCE	TOLERANCE
Nanophyes	**Flower Weevils**				
annulatus		W. Europe	Stem, leaf	High	Low
circumscriptus		N. and C. Europe	Stem, leaf	Very low	High
globiformis		S. and C. Europe	Stem	?	?
helveticus		S. and C. Europe	Stem	Low	Medium
marmoratus		Widespread	Seeds	High	High
brevis		S. Europe	Seeds	Medium-high	High
nitidulus		S. and C. Europe	Stem	?	High
Coleophora	**Case Moths**				
paripennella		Europe	Leaf	Medium	High
Galerucella	**Leaf Beetles**				
pusilla		Widespread	Leaf, stem	High	High
calmariensis		Widespread	Leaf, stem	High	High
Lygus	**Leaf Bugs**				
pratensis		N. Yugoslavia	Leaf	?	High
Hylobius	**Root Weevils**				
transverovittatus		Widespread E. Austria	Root	Low	Medium
Ametastegia	**Sawflies**				
glabrata		N. America	Leaf	High	High
Adelphocoris	**Plant Bugs**				
seticornis		N. Yugoslavia	Leaf	High	High
Acleris	**Noctuid Moths**				
lorquinainae		W. Europe	Flower	Very low	Medium
Philaenus	**Spittlebugs**				
spumarius		Widespread	Stem, leaf, flower	High	Low
Deilephila	**Sphinx Moths**				
paludella		E. Austria	Leaf	High	Medium
Dasineura	**Midges**				
salicariae		Widespread	Stem, buds	High	High
Taeniothrips	**Thrips**				
discolor		Widespread	Flower	High	High
Aphthona	**Beetles**	E. Austria			
lutescens		N. Italy	Roots	High	Medium



LOOSESTRIFE SPECIFIC	LOOSESTRIFE EFFECT	PARASITES	FECUNDITY	MISCELLANEOUS COMMENTS
?	High on stems	No	Low	Hard to catch
Yes	?	No	Low	
Yes	?	No	Low	Mines the stems
Yes	?	No	Low	
Yes	80% destruction	No	Medium	
Yes		Nematode	Medium	
On *Lythrum hyssopifolia*	40%	No	Medium	
No	?	No	High	Mines the leaves
Yes	80% leaves	No	High	Up to 4 generations/ year if warm
Yes	80% leaves	No	High	
No	?	No	High	
Yes	High on roots	No	High	Long lived
No	Medium	No	High	
Eats legumes	?	No	High	
Yes	?	No	Low	Easy to attract and catch
No	Damages whole plant	No	Medium	Easy to catch
No	Often high local damage	No	Medium	
Yes	75% seed 80% leaves	Parasitic wasp	High	
No	50% flowers destroyed	No	High	
Yes	Effective	No	Medium	Kills other insects' eggs

NOTES:

Scientific name—Capitalized name is the genus for insect species below it. Lower case names are species of the genus above them. Scientific names include both genus and species.

Plant Part—Most commonly attacked part of purple loosestrife.

Abundance—Number of insect individuals encountered where it is found.

Tolerance—Ability of insect to be manipulated, e.g., grown in captivity.

Loosestrife specific—Does insect live only on loosestrife? (Some alternate hosts listed.)

Parasites—Does the insect have parasites or other companion organisms hard to separate from it?

Fecundity = Number of offspring the insect produces/time